Economics and Human Biology 8 (2010) 405–413

Contents lists available at ScienceDirect

Economics and Human Biology

journal homepage: http://www.elsevier.com/locate/ehb

Long run trends in the heights of European men, 19th–20th centuries☆

Timothy J. Hatton [a,b,*], Bernice E. Bray [c]

[a] Australian National University, Australia
[b] University of Essex, UK
[c] Université Paris I, France

ARTICLE INFO

Article history:
Received 11 October 2009
Received in revised form 21 March 2010
Accepted 21 March 2010

JEL classification:
I12
J31
N34

Keywords:
Height
Europe
20th century

ABSTRACT

This paper presents 5-yearly data on the height of young adult men in 15 Western European countries for birth cohorts from the middle of the 19th to the end of the 20th century. The results indicate that from the 1870s to the 1970s average height increased by around 11 cm, or more than 1 cm per decade. The main finding is that for the northern and middle European groups of countries the gains in height were most rapid in the period 1911–15 to 1951–55, a period that embraced two World Wars and the Great Depression but also witnessed advances in public health and hygiene. For the southern countries growth was fastest in the period 1951–55 to 1976–80. These findings suggest that advances in height were determined not only by income and living standards but also by a variety of other socioeconomic trends.

1. Introduction

There is a large literature that treats average height as a key measure of physical welfare or what is sometimes called the biological standard of living. It is well established that height is influenced by nutrition and disease. Economic historians have extensively analysed the links between stature and other indicators of economic development during the 18th and 19th centuries, a literature that is outlined in surveys by Komlos (1994), Komlos and Baten (2004) and Steckel (1995, 2009) among others. While this literature has produced a variety of important insights, it focuses less on the period that has seen the most rapid improvement in health—the 20th century.[1] A parallel literature by epidemiologists and health economists has focused on trends in average height since the 1950s as well as on the socioeconomic correlates of growth during childhood (Cole, 2000; Silventoinen, 2003). However, this typically fails to capture the longer term evolution in height that has been in train since the late 19th century.

One reason for the gap between these two literatures is that individual datasets often span just a few decades or cover birth cohorts for a few specific dates. Our purpose here is to provide a new database for the average height of

☆ We have benefitted from the help of a large number of individuals: Emilia Arcelini, Joerg Baten, Nicolas Herpin, John Komlos, Ramón María-Dolores, Climent Quintana-Domeque, Rick Steckel and Mathias Sinning all provided us with data from their own research. We also received generous help from national statistical offices, particularly from Karin Lange (Federal Statistical Office of Germany), Karen Larsen (Statistics Denmark), Yvan Schobbens (Statistics Belgium), Jeannette Klimont (Statistics Austria) and Ragnhild Bore (Statistics Norway). We have also received valuable advice from David Weil, John Relethford, and Cormac Ó Gráda as well as constructive comments from the editor and five referees.

* Corresponding author at: Department of Economics, University of Essex, Colchester CO4 3SQ, UK. Tel.: +44 1206 873417; fax: +44 1206 872724.
E-mail address: hatton@essex.ac.uk (T.J. Hatton).

[1] Notable exceptions include Floud (1994), Cavelaars et al. (2000), Komlos and Kriwy (2003), Komlos and Baur (2004) and Komlos and Lauderdale (2007).

1570-677X/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.ehb.2010.03.001

young adult men in 15 European countries for birth cohorts extending from 1856 to 1860, or as early as the sources permit, up to 1976–80. Our series are constructed for each country by piecing together data on average height from different sources in different periods. For the more recent decades we rely mainly on height-by-age from cross-sectional surveys, and we carry the series further back in time using data for the height of military recruits or conscripts—many of which have been previously analysed by economic historians. Historical evidence on female height is severely limited and for that reason we focus only on the height of men. The final series are reported in full in Appendix B.

2. Sources and methods of construction

For the most recent period, ending with the birth cohort 1976–80, we build on the heights database provided by Garcia and Quintana-Domeque (2007), which we use for nine countries. These are based on height-by-age data from the European Community Panel of 1994–2001. They include only adults observed at ages between 21 and 51. This avoids the effect of increasing height during adolescence as well as the effect of shrinkage at higher ages that would otherwise introduce spurious upward trends as we move from older to younger cohorts. We have added another six countries, four of which are based on other sources of data on average height-by-age. Details of the sources and methods are reported in Appendix A.

The series provided by Garcia and Quintana-Domeque, as well as some of those that we have added, are for self-reported height, which is known to be upwardly biased compared with true (measured) height. Although the self-reporting bias varies across individuals, studies that have compared self-reported with measured height typically find that that the average upward bias in self-reporting is less than a centimetre for prime age men.[2] For the postwar series that are based on self-reported height, we make a downward adjustment of 0.8 cm. This should ensure a reasonable degree of comparability with those countries and periods for which we have measured height. We carry the series back in time by splicing to an overlapping 5-year period, so that we do not create spurious jumps as a result of shifting from height-by-age data to the series for military recruits or conscripts as we move back in time. In most cases the absolute height adjustments we make for the earlier periods at the splice points are small.

For military recruits we have used a variety of sources, obtained either from published studies or from national statistical bureaux. As the average age of military recruits or conscripts is typically around age 20, we assume that the birth year is the date of enrolment minus 20. As is well known, the average height of military recruits can be affected by minimum height requirements and we have adopted series that are adjusted for truncation wherever these are available. In some cases where there is universal conscription the data reported are for all those who were subject to a medical rather than only for those were recruited.[3] In our period selection criteria are likely to have changed over the two world wars but we have not attempted to adjust for this.

In a few cases we have used linear interpolations where we lack observations for one or two periods. But there remain gaps in the series for three countries. For Germany and Austria these are complicated by changes in national boundaries, and for Ireland we lack any information for the half-century between 1901–05 and 1951–55.

3. Trends in average height

Table 1 presents the average increase in height per decade over the whole period from 1871–75 to 1976–80, and for three major eras: 1871–75 to 1911–15 (prewar), 1911–15 to 1951–55 (transwar) and 1951–55 to 1976–80 (postwar). Over the century, average height increased at rates around 1 cm per decade, with a range between 0.8 and 1.4 cm per decade. The rate of increase was slower in the prewar period than for the century as a whole, except for Great Britain. But perhaps the most striking feature of the table is the rapid increase in height during the transwar period. While this period must be treated with caution because of breaks in the data, there seems little doubt that the trend in height accelerated some time after the turn of the century (Millward and Baten, 2010). It is also worthy of note that, while most countries experienced a slowdown in growth after the Second World War, the southern European countries experienced a continued acceleration.

An alternative way to summarise these patterns is to estimate trends over time using regressions rather than relying on end points. We group the countries into north (Scandinavia and the Netherlands), middle (Austria, Belgium, Germany, Great Britain, and Ireland) and south (France, Italy, Greece, Portugal, and Spain). Table 2 presents regressions of height on a time trend with fixed effects by country, and including dummies for within-period breaks (affecting only the middle group) Although this grouping is somewhat arbitrary, it confirms the patterns that were seen in Table 1. In the north group the rate of increase almost doubles in the transwar period and then returns to a more modest figure. For the middle countries the pattern is similar but not quite as pronounced, while for the south group, growth accelerates across all three periods.

A number of studies have compared trends in height across European countries. One of the most distinct

[2] To give a few examples: Bostrom and Diderichsen (1997) find an upward bias of 0.6 cm in a sample Stockholm men aged 18–84; Spencer et al. (2002) find a bias of 0.8 cm for men aged 35–49 in the EPIC-Oxford sample; Niedhammer et al. (2000) find a bias of 0.4 cm for men aged 45–54 in the French GAZEL cohort; and Kuczmarski et al. (2001) find a bias of 0.9 cm in the US NHANES men aged 20–49. The bias in self-reported heights is often larger at higher ages where there has been some decrease in height and where individuals are likely to report a perception of their height at a somewhat younger age.

[3] For example in 1871 Germany passed a universal conscription law requiring all 20-year-old men to present themselves for a medical examination (Twarog, 1997), Italy passed a similar law in 1863 leading to the examination of all young men (Arcaleni, 2006).

Table 1
Increase in height in centimetres per decade.

	1871–75 to 1976–80	1871–75 to 1911–15	1911–15 to 1951–55	1951–55 to 1976–80
Austria	1.11	0.59	1.50	1.32
Belgium	1.08	0.41	1.59	1.32
Denmark	1.24	0.58	1.83	1.37
Finland				0.84
France	0.91	0.57	1.10	1.16
Germany	1.25			1.20
Great Britain	0.93	1.14	0.99	0.50
Greece				1.55
Ireland	0.80			1.00
Italy	1.06	0.72	1.14	1.50
Netherlands	1.41	1.34	1.32	1.67
Norway	0.93	0.79	1.49	0.26
Portugal			0.94	1.72
Spain	1.19	0.74	0.79	2.53
Sweden	0.97	0.68	1.25	1.00
Average	1.08	0.76	1.27	1.26
Std Deviation	0.18	0.28	0.31	0.54

findings is the steep north–south gradient, with the tallest in the Netherlands, Denmark, Norway and Sweden and the shortest in France, Spain, Portugal and Italy. Using height-by-age for individuals aged 20–74 (cohorts from 1920 to 1970) in 10 European countries Cavelaars et al. (2000) found that there was a striking persistence in height differentials both across countries and social classes. Examining their data for 1950–1980 birth cohorts Garcia and Quintana-Domeque (2007) find similar differentials. While there is some evidence of faster growth among southern Europeans, leading to convergence with northern Europe, there seems to be no convergence among the countries within each group. Data for conscripts suggests that growth has virtually come to a halt in northern Europe and may have started to slow down in Southern Europe (Silvientonin et al., 2001; Larnkjær et al., 2006; Papadimitriou et al., 2008). It is interesting to compare this experience with that of the United States which was tallest among developed countries in the early 20th century but has experienced almost no increase in the height of native-born men since the 1950s (Komlos and Lauderdale, 2007).

Table 3 offers a longer term view by showing correlation coefficients for height across countries between pairs of dates. As expected, the coefficients are largest for dates that are relatively close in time. However,

Table 2
Coefficient on time trend (cm per decade).

	1871–75 to 1976–80	1871–75 to 1911–15	1911–15 to 1951–55	1951–55 to 1976–80
North				
Coefficient	1.24	0.84	1.43	0.99
t-value	41.8	13.5	22.5	8.1
Observations	96	36	39	30
Countries	5	4	5	5
Middle				
Coefficient	1.13	0.80	1.36	1.02
t-value	32.3	8.1	16.6	9.0
Observations	91	39	30	30
Countries	5	5	5	5
South				
Coefficient	1.12	0.68	1.05	1.70
t-value	22.9	20.8	9.9	11.5
Observations	91	28	42	30
Countries	5	4	5	5

Note: north: Denmark, Finland, Netherlands, Norway, Sweden; middle: Austria, Belgium, Germany, Great Britain, Ireland; south: France, Italy, Greece, Portugal, Spain.

Table 3
Cross country correlations at different dates.

	1871–75	1911–15	1951–55	1976–80
1871–75	1			
1911–15	0.91	1		
1951–55	0.89	0.96	1	
1976–80	0.70	0.87	0.92	1

Note: correlation coefficients across countries at different dates, for the countries on which we have average height observations at both dates.

over a century or more the correlation is considerably weaker. There also appears to be some divergence up to the Second World War, followed by convergence. The standard deviation of height across countries increased by 0.3 between 1871–75 and 1911–15 (10 countries) and by 0.9 between 1911–15 and 1951–55 (11 countries) and then fell by 0.7 between 1951–55 and 1976–80 (15 countries).

4. Discussion

To summarise, we find that, across Western Europe, average heights have consistently increased for over a century and that the total gain has been around 11 cm. In north and middle Europe the increase seems to have been particularly strong between 1911–15 and 1951–55, while period of most rapid increase came somewhat later in southern Europe. While researchers have often identified similar trends for a subset of countries or for shorter periods, our dataset puts those findings into a longer term perspective. There remains the question of how these patterns can best be explained, and in particular, why the increase in height was so strong in the period that embraced two World Wars and the Great Depression.

Several influential studies have used regression analysis to link the variations in height to income per capita, particularly from the mid-19th century up to 1930 (Floud, 1994; Steckel, 1995). The effects are strongly positive, especially after the middle decades of the 19th century. It seems likely that the surge in height during the 20th century, as compared with the 19th century, owes something to faster economic growth. But the correspondence works less well across our three periods. According to Maddison's data the GDP per capita of Western Europe grew at annual rates of 1.3% from 1870 to 1913, 0.9% from 1913 to 1951, and 3.5% from 1951 to 1980. Thus height increased most rapidly in the period of slowest economic growth. If the effect of income on height is associated with improved nutrition, its impact might be expected to weaken as Europe progressively escaped from poverty.[4] This might account for somewhat weaker income effects during the Europe's golden age of economic growth. But it is more difficult to explain why height increased so strongly in the transwar period as compared with the 40 years before World War 1. One possibility is that the relative price of food fell and its nutrition content improved in the period from 1914 to 1945.

Height is determined not only by nutrition but also by the disease environment, which improved significantly in the first half of the 20th century. But as McKeown (1976) argued, most of the major innovations in medical technology did not become available until the late 1930s or the 1940s. And while medical services improved during the interwar period, comprehensive health services were not developed until after the Second World War. However, improvements in urban sanitation that had been in train since the late 19th century may have been more important than doctors and medicines, at least up to the 1930s. Ever since Edwin Chadwick, observers have stressed the link between clean water supply and sewage treatment and the health of urban populations.[5] Although these effects are still debated, recent studies have indicated that sanitary reforms had substantial effects on death rates, and particularly on infant mortality rates (Bell and Millward, 1998; Cutler and Miller, 2005).

In a recent study Bozzoli et al. (2009) examine country-level data on the average height of adults born between 1950 and 1980 (some of the same data that is reported here). Using postneonatal mortality in the cohort's birth year as a proxy for the disease environment they find a negative effect that accounts for most of the increase in height over the period. This is consistent with the results reported by Schmidt et al. (1995) and for earlier periods by Crimmins and Finch (2005), who use infant mortality as their proxy for the disease environment. Across Europe, infant mortality fell particularly steeply after the turn of the 20th century. For the countries in our dataset, infant mortality rates fell from an average of 178 per thousand in 1871–75 to 120 per thousand in 1911–15 and then plummeted to 41 in 1951–55 and 14 in 1976–80. To the extent that infant mortality captures the disease environment, this could have contributed to the acceleration in height from the late 19th century.

While infant mortality has been associated with sanitary reforms it also reflects conditions at the household level, including housing quality and overcrowding. A study of Glasgow and Edinburgh suggests that the effects of overcrowding weakened over the 20th century (Cage and Foster, 2002), possibly due to improvements in housing quality. Perhaps more important were improvements in household technology and in child nurturing practices. Specific improvements identified in the literature include better quality milk supplies, better knowledge of hygiene and feeding methods (particularly bottle feeding) as well as the growing importance of local health services. Mokyr (2000) argues that improved knowledge of nutrition and of the channels through which disease is transmitted led mothers to devote more time and effort to child nurturing and housework than they otherwise would have.

The quality–quantity trade-off suggests that smaller family size was a key factor that made possible such improvements in child nurturing practices. Thus the fertility transition, which saw a dramatic fall in birth rates from the late 19th century, may have been important. For the countries studied here the downward trend was particularly strong between the 1900s and the 1930s. This would have reduced the burden of poverty for working class families with children and its timing may not be captured very well by the trend in aggregate income per capita. One recent study of micro-data on children in 1930s Britain finds that household income per capita had a strong positive effect on height, and that falling family size accounts for up to two fifths of the increase in children's

[4] The idea of a concave health production function is widely acknowledged in the literature (Steckel, 1995, p. 1912; Easterlin, 1999, p. 259).

[5] McKeown argued that sanitary reforms had little effect on death rates in Victorian Britain, but the issue is still contested, see Szreter (1988) and Guha (1994).

height between 1906 and 1938 (Hatton and Martin, 2009). For French Départements, Weir (1993) found an inverse relationship between the height of young adults and lagged fertility rates over whole of the 19th century.

Although the link between height and income is well established in the literature, it is obviously only one of the many causal factors. Changes in the size and structure of families as well as the urban infrastructure and other improvements in the disease environment may also have been important. Those forces are likely to have been increasingly influential in the first half of the 20th century. Our challenge in future research is to use our database to provide a fuller quantitative account of the forces that have shaped the distinctive patterns of increase in European height since the late 19th century.

Appendix A. Data sources and methods

For nine countries, data on birth cohorts between 1951–55 and 1976–80 were taken from Garcia and Quintana-Domeque (2007). These are based on cross-sectional height-by-age observations obtained from the European Household Community Panel in 1994–2001. Heights are self-reported and, unless otherwise stated, they have been adjusted down by 0.8 cm. Series from other sources (usually conscripts) have been spliced back in time. As the typical age of conscripts is about 20, date of birth is taken to be date of observation minus 20. The sources for each country and period are listed below.

A.1. Austria

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1951–55 was the benchmark for the series; heights back to 1936–40 were adjusted to remain coherent with this average. 1936–40 to 1951–55: 5-year average of heights of Austrian recruits aged 21 from annual data kindly supplied by John Komlos. 1856–60 to 1911–15: height of Austrian recruits aged 21 from annual data kindly supplied by John Komlos (from Komlos, 2007). 5-year averages are used for 1856–90, single year observations from 1895, 1900, 1905, 1910 and 1915 are used for 1891–95 to 1911–15. These data are not linked to the series for 1936–40 onwards.

A.2. Belgium

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1951–55 was the benchmark for the series; earlier heights were adjusted to remain coherent with this average. 1941–45: height of Belgian conscripts from Belgian *Statistical Yearbook* (1971) p. 98. Average calculated with data for 1942 and 1945. 1931–35: height of conscripts aged 19–20 born in 1933 from Martin (1958) as cited in Chamla (1964) p. 231, single year observation. 1926–30 and 1861–65: height of Belgian conscripts born in 1927 and in 1861 from *Projekt Vlaamse Groeicurven*, from Statistics Belgium (2009). 1891–95, 1916–20 and 1936–40: height of Belgian conscripts from Belgian *Statistical Yearbook* (1971) p. 98; Heights for 1891, 1918 and 1940. 1866–70 to 1886–90 and 1896–1915: height of 20-year-old Belgian conscripts from Belgian *Statistical Yearbooks* (1906, 1920–21, 1927–28, 1933, 1939); median calculated from height distribution. Single year observations for 1868, 1870, 1875, 1880, 1884, 1900, 1906, 1909 and 1915 are used to represent the 5-year periods. Height for 1900 was adjusted down 5 mm as the conscripts that year were older than 20. 1921–25 and 1946–50: linear interpolation between adjacent observations.

A.3. Denmark

1956–60 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1956–60 height for age gives the benchmark of the series, earlier heights were adjusted for coherence. 1896–1900 to 1951–55: height of conscripts aged 20, 5-year averages from annual data kindly supplied by John Komlos (from Komlos and Lauderdale, 2007). 1881–85 to 1891–95: height of conscripts aged 20 from Statistics Denmark (1966) p. 159. Single year observations were used, as annual data were unavailable. 1876–80: height of conscripts aged 20 from *Statistical Yearbook of Denmark* (2008). 1871–75: linear interpolation between adjacent observations. 1856–60 to 1866–70: height of conscripts aged between 18 and 21 from Statistics Denmark (1892) p. 93 (Danish inches converted to centimetres).

A.4. Finland

1966–70 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1966–70 was the benchmark for the series, earlier heights were adjusted to remain coherent with this average.1941–45 to 1961–65: height-by-age measured in 1994 from the Survey on Living Conditions in Finland taken from Silvientonin et al. (2001) p. 126.

A.5. France

1941–80: height-by-age measured in 2001 from the *Enquête permanente sur les conditions de vie*, measured in 1970, 1980 and 1991 from the enquêtes Santé, taken from Herpin (2003), p. 73. Height is adjusted down 0.8 cm to correct for bias in self-reporting; height for age in 1941–45 is used as the benchmark for the series; all earlier heights were adjusted to remain coherent. 1856–1940: median height of 20-year-old military recruits (adjusted for changes in the minimum height requirement) from Van Meerten (1990) pp. 775–776, 5-year averages from annual data.

A.6. Germany

1951–55 to 1976–80: height-by-age measured in 2001 from the SOEP (German Socio-Economic Panel Study), kindly provided by Mathias Sinning. Data exclude immigrants but

include those born in East and West Germany. Height is adjusted down 8 mm to correct for bias in self-reporting. 1926–30 to 1946–50: median height-by-age measured in 1978 from the *Mikrozensus: Frage zur Gesundheit* health survey, data kindly supplied by Karin Lange of the Federal Statistical Office of Germany. Heights are for West Germany only and were adjusted down 8 mm to correct for bias in self-reporting. The series was benchmarked on the 1953-1957 West German average male height from the SOEP and a second downward adjustment was made, this time of 9 mm to correspond to the 5-year periods under study. 1856–60 to 1891–95: height of 20-year-old conscripts from Württemberg from Twarog (1997) p. 296 (adjusted for truncation due to minimum height requirements by the army). Original data were given in 2-year averages so here alternating 6-year then 4-year averages are used for successive quinquennia. As those from Württemberg are shorter than the average for Germany we have increased them by 1.5 cm. This would be consistent with the regional differences identified by Baten (2003) and Hiermeyer (2009) and also with the latter's finding that conscript heights increased by 12.5 cm between those observed in 1906 and in 2000/1. Nevertheless, we do not have a direct link to the series for 1926–30 onwards.

A.7. Great Britain

1956–60 to 1976–80: height-by-age measured in 2000 from Health Survey for England (kindly supplied by Climent Quintana-Domeque); 1931–35 to 1956–60: height-by age measured in 1980 from Rosenbaum et al. (1985), p. 117 (this is taken as the base for the series); 1906–10 to 1931–35: height-by-age self-reported in 1946 and 1958 from Kuh et al. (1991), p. 1003; 1886–90 to 1906–10: height-by-age measured in 1943 from Kemsley (1950) p. 163; 1861–5 to 1886–90: heights of army recruits age 20 (adjusted for truncation) from Rosenbaum (1988), p. 282.

A.8. Greece

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). Even after adjustment for self-reporting these appear to be inconsistent with data on conscripts and so they were adjusted downwards to the conscript heights for the 1966–70 cohort reported by Papadimitriou et al. (2008) p. 1106. 1926–30 to 1941–45: height of Greek conscripts from Sapounaki-Dracaki (1998) p. 412.

A.9. Ireland

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1901–05: height of male prisoners from Ó Gráda (1994) p. 245, height given in inches and converted to centimetres, earlier heights were adjusted down to remain coherent with the height from this period. 1871–75 to 1896–1900: height-by-age from Relethford (1995) pp. 251, measured between 1934 and 1936. These data are not linked to the series for 1951–55 onwards.

A.10. Italy

1856–60 to 1976–80: height of 20-year-old Italian conscripts (adjusted to correct for the presence of conscripts older and younger than 20); 5-year averages calculated using annual data. Data supplied by the Italian defence force to Instituto Nazionale di Statistica as reported in Arcaleni (2006), kindly provided by Emilia Arcelini. 1921–25: linear interpolation between adjacent periods, as no conscript height data exist for this period corresponding to the 1941–45 conscription years

A.11. The Netherlands

1931–35 to 1976–80: height-by-age from Statistics Netherlands *Health Interview Survey* for 1981–4 and 2001–4, height was adjusted down 8 mm to correct for bias in self-reporting. 1926–30: average height of conscripts aged 18.5 from the *Statistical Yearbook of the Netherlands* (1962), p. 46, single year observation from 1930, heights were increased by 1 cm to correct for the lower age of the conscripts. This series was spliced into the later series at 1931–36. 1921–25: linear interpolation between adjacent observations, as no conscript height data exist for the period corresponding to the 1941–45 conscription years. 1856–1920: median height of conscripts aged 19 and 3/4 from Drukker and Tassenaar (1997) p. 331.

A.12. Norway

1926–30 to 1976–80 and 1909–20: height of conscripts aged 21 (for 1909–35) and 20 (for 1936–80) from the Norwegian Conscription Service through Statistics Norway (2009). Heights are 5-year averages except for 1916–20 and 1926–30 which are from single observations during the periods (the years 1918 and 1926). 1921–25: linear interpolation of surrounding heights, as no conscript height data exist for this period corresponding to the 1941–45 conscription years. 1908–09: height of conscripts aged 21 from the *Statistical Yearbook for Norway* (1935) p. 35. 1886–90 to 1901–06: height of conscripts aged 21 from the *Statistical Yearbook for the Kingdom of Norway* (1929), 5-year averages. 1861–5 to 1881–85: height of conscripts aged 22 from the *Statistical Yearbook for the Kingdom of Norway* (1929), observations every 5 years. 1861–5 to 1876–80 do not include conscripts from the 3 Northern Regions of Norway.

A.13. Portugal

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1951–55 height for age gives the benchmark of the series; earlier heights were adjusted for coherence. 1911–6 to 1946–50: height of 20-year-old

Southern Portuguese conscripts from Sobral (1990) p. 496. 10-yearly observations on average heights in regions of southern Portugal are combined using population weights.

A.14. Spain

1951–55 to 1976–80: height-by-age from Garcia and Quintana-Domeque (2007). 1951–55 height for age gives the benchmark of the series; earlier heights were adjusted for coherence.1856–60 to 1946–50: standardised height of 21-year-old conscripts from Maria-Dolores and Martinez-Carrion (2009).

A.15. Sweden

1956–60 to 1976–80: height-by-age from Garcia and Qunitana-Domeque (2007). 1856–6- to 1951–55: height of conscripts aged 20 from Sandberg and Steckel (1997) p. 127.Single year observations are used for each 5-year period; this series was spliced into the later one based on a 1956–60 benchmark.

Appendix B Mean heights of men by birth cohorts, 1856–60 to 1976–80

Period	Austria	Belgium	Denmark	Finland	France	Germany	Gt. Britain
1856–60	165.78		168.48		166.42	166.98	
1861–65	165.94	166.83	168.12		166.56	167.64	166.25
1866–70	166.77	167.09	168.14		166.54	167.34	166.05
1871–75	167.15	167.37	*168.34*		166.64	167.03	167.05
1876–80	167.40	168.09	168.54		166.70	167.27	167.25
1881–85	167.60	167.84	168.94		166.93	167.65	167.05
1886–90	167.97	167.81	169.34		167.29	167.67	168.85
1891–95	169.55	167.34	169.34		167.56	168.48	169.37
1896–1900	168.48	168.18	169.25		167.93		169.88
1901–05	171.06	168.34	169.71		168.03		171.29
1906–10	171.01	168.55	170.07		168.40		171.53
1911–15	169.51	169.03	170.66		168.92		171.60
1916–20		169.55	171.69		169.20		171.90
1921–25		*170.36*	172.96		169.48		172.82
1926–30		171.17	173.36		169.06	172.99	173.60
1931–35		173.08	174.02		169.37	173.88	173.86
1936–40	173.06	173.38	174.23		170.41	174.90	173.87
1941–45	174.46	173.38	176.58	174.32	171.70	175.47	174.77
1946–50	174.80	*174.39*	176.84	174.32	171.70	176.35	175.17
1951–55	175.50	175.40	177.97	175.81	173.30	177.37	175.57
1956–60	176.20	176.50	178.90	175.81	173.30	178.38	176.27
1961–65	178.40	176.40	180.20	177.10	175.60	179.09	176.77
1966–70	177.70	178.60	180.90	177.10	175.60	179.44	176.86
1971–75	177.90	178.40	181.20	177.20	176.20	179.92	177.37
1976–80	178.80	178.70	181.40	177.90	176.20	180.17	176.83

Period	Greece	Ireland	Italy	Nethlds	Norway	Portugal	Spain	Sweden
1856–60			162.61	166.52			162.21	168.40
1861–65			162.92	167.18	168.87		162.64	169.50
1866–70			163.25	167.76	169.87		163.12	169.00
1871–75		168.24	163.31	167.89	169.87		162.84	170.20
1876–80		168.73	163.70	168.37	169.87		163.14	170.30
1881–85		168.93	163.69	169.16	169.87		163.76	170.90
1886–90		168.53	163.90	169.71	171.06		163.99	171.50
1891–95		168.63	164.46	170.20	170.86		164.02	172.30
1896–1900		169.61	164.88	170.65	170.86		164.27	172.40
1901–05		170.00	165.34	171.53	171.86		164.72	172.50
1906–10			165.85	172.36	172.20		165.71	173.00
1911–15			166.17	173.24	173.02	164.24	165.81	172.90
1916–20			166.57	174.00	173.66	164.24	165.71	173.40
1921–25			*166.90*	*173.98*	*174.76*	165.44	165.06	174.10
1926–30	166.75		167.23	173.96	175.86	165.44	165.14	174.80
1931–35	167.20		167.72	174.96	176.56	166.19	166.13	175.20
1936–40	167.40		168.36	175.41	177.12	166.19	166.75	175.80
1941–45	167.18		168.93	175.99	177.98	166.89	167.26	176.10
1946-1950	*170.30*		169.75	177.02	178.52	166.89	167.65	177.40
1951–55	173.41	174.30	170.73	178.53	178.98	168.00	168.97	177.90
1956–60	174.11	175.50	172.27	179.88	179.42	169.20	170.90	178.60
1961–65	175.30	175.30	173.76	180.51	179.38	169.20	172.50	180.10
1966–70	175.70	176.10	173.76	181.43	179.80	169.00	173.90	179.70
1971–75	177.09	176.20	174.14	181.90	179.60	171.30	174.90	179.60
1976–80	177.29	176.60	174.48	182.70	179.63	172.30	175.30	180.40

Note: linearly interpolated values in italic.

References

Arcaleni, E., 2006. Secular trend and regional differences in the stature of Italians, 1854-1980. Economics and Human Biology 4, 24–38.

Baten, J., 2003. Anthropometrics, consumption and leisure: the standard of living. In: Oglivie, S., Overy, R. (Eds.), Germany: A New Social and Economic History, vol. III: 1800–1989. Edward Arnold, London.

Bell, F., Millward, R., 1998. Public health expenditures and mortality in England and Wales, 1870–1914. Continuity and Change 13, 21–249.

Bostrom, G., Diderichsen, F., 1997. Socioeconomic differentials in misclassification of height, weight and body mass index based on questionnaire data. International Journal of Epidemiology 26, 860–866.

Bozzoli, C., Deaton, A.S., Quintana-Domeque, C., 2009. Adult height and childhood disease. Demography 76, 647–669.

Cage, R.A., Foster, J., 2002. Overcrowding and infant mortality: a tale of two cities. Scottish Journal of Political Economy 49, 29–149.

Cavelaars, A.E.J.M., Kunst, A.E., Geurts, J.J.M., Crialesi, R., Grötvedt, L., Helmert, U., Lahelma, E., Lundberg, O., Mielk, A., Rasmussen, N.K., Regidor, E., Spuhler, T., Mackenbach, J.P., 2000. Persistent variations in average height between countries and between socio-economic groups: an overview of 10 European countries. Annals of Human Biology 27, 407–421.

Chamla, M.-C., 1964. L'accroissement de la stature en France de 1880 à 1960. Bulletins et Mémoires de la Société d'anthropologie de Paris 6, 201–278.

Cole, T.J., 2000. Secular trends in growth. Proceedings of the Nutrition Society 59, 317–324.

Crimmins, E.M., Finch, C.E., 2005. Infection, inflammation, height and longevity. Proceedings of the National Academy of Science 103, 498–503.

Cutler, D., Miller, G., 2005. The role of public health improvements in health advances: the twentieth century United States. Demography 42, 1–22.

Drukker, J.W., Tassenaar, V., 1997. Paradoxes of modernization and well-being in the Netherlands during the nineteenth century. In: Steckel, R.H., Floud, R. (Eds.), Health and Welfare During Industrialization. University of Chicago Press, Chicago, pp. 331–377.

Easterlin, R.A., 1999. How beneficent is the market? A look at the modern history of mortality. European Review of Economic History 3, 257–294.

Floud, R., 1994. The heights of Europeans since 1750: a new source for European economic history. In: Komlos, J. (Ed.), Stature, Living Standards and Economic Development. University of Chicago Press, Chicago.

Garcia, J., Quintana-Domeque, C., 2007. The evolution of adult height in Europe: a brief note. Economics and Human Biology 5, 340–349.

Guha, S., 1994. The importance of social intervention in England's mortality decline: the evidence reviewed. Social History of Medicine 7, 89–113.

Hatton, T. J. and Martin, R. M., 2009. Fertility decline and the heights of children in Britain, 1886–1938. IZA Discussion Paper 4306, Bonn: IZA.

Herpin, N., 2003. La taille des hommes: son incidence sur la vie en couple et la carrière professionnelle. Economie et Statistique 361, 71–90.

Hiermeyer, M., 2009. Height and BMI values of German conscripts in 2000, 2001 and 1906. Economics and Human Biology 7, 366–375.

Kemsley, W.F.F., 1950. Weight and height of a population in 1943. Annals of Human Genetics 15, 161–183.

Komlos, J., 1994. On the significance of anthropometric history. In: Komlos, J. (Ed.), Stature, Living Standards and Economic Development. University of Chicago Press, Chicago.

Komlos, J., 2007. Anthropometric evidence on economic growth, biological well-being and regional convergence in the Habsburg Monarchy in 1850–1910. Cliometrica 1, 211–237.

Komlos, J., Baten, J., 2004. Looking backward and looking forward: anthropometric research and the development of social science history. Social Science History 28, 191–210.

Komlos, J., Baur, M., 2004. From the tallest to (one of) the fattest: the enigmatic fate of the size of the American population in the twentieth century. Economics and Human Biology 2, 57–74.

Komlos, J., Kriwy, P., 2003. The biological standard of living in the two Germanies. German Economic Review 4, 493–507.

Komlos, J., Lauderdale, B.E., 2007. Underperformance in affluence: the remarkable relative decline in U.S. heights in the second half of the 20th century. Social Science Quarterly 88, 283–305.

Kuczmarski, M.F., Kuczmarski, R.J., Najjar, M., 2001. Effects of age on validity of self-reported height, weight and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. Journal of the American Dietetic Association 101, 28–34.

Kuh, D.L., Power, C., Rodgers, B., 1991. Secular trends in social class and sex differences in adult height. International Journal of Epidemiology 20, 1001–1009.

Larnkjær, A., Schrøder, S.A., Schmidt, I.N., Jørgensen, M.H., Michaelsen, K.F., 2006. Secular change in adult stature has come to a halt in northern Europe and Italy. Acta Pædiatrica 95, 754–755.

Maria-Dolores, R. and Martinez-Carrion, J. M., 2009. The relationship between height and economic development in Spain, 1850–1958, University of Murcia. Working paper No. 10.

McKeown, T., 1976. The Modern Rise of Population. Edward Arnold, London.

Millward, R., Baten, J., 2010. Population and living standards, 1914–1945. In: Broadberry, S., O'Rourke, K.H. (Eds.), The Cambridge Economic History of Modern Europe, Vol. 2. Cambridge University Press, Cambridge.

Mokyr, J., 2000. Why "more work for mother?" knowledge and household behavior, 1870–1945. Journal of Economic History 60, 1–41.

Niedhammer, I., Bugel, I., Bonenfant, S., Goldberg, M., Leclerc, A., 2000. Validity of self-reported height in the French GAZEL Cohort. International Journal of Obesity 24, 1111–1118.

Ó Gráda, C., 1994. Ireland A New Economic History 1780–1939. Clarendon Press, Oxford.

Papadimitriou, A., Fytanidis, G., Douros, K., Papadimitriou, D.T., Nicolaidou, P., Fretzayas, A., 2008. Greek young men grow taller. Acta Paedriatrica 97, 1105–1107.

Relethford, J.H., 1995. Re-examination of secular change in adult Irish stature. American Journal of Human Biology 7, 249–253.

Rosenbaum, S., 1988. 100 years of heights and weights. Journal of the Royal Statistical Society (Series A) 151, 276–309.

Rosenbaum, S., Skinner, R.K., Knight, I.B., Garrow, J.S., 1985. A survey of heights and weights of adults in Great Britain, 1980. Annals of Human Biology 12, 115–127.

Sandberg, L.G., Steckel, R.H., 1997. Was industrialization hazardous to your health? Not in Sweden!. In: Steckel, R.H., Floud, R. (Eds.), Health and Welfare During Industrialization. University of Chicago Press, Chicago, pp. 127–159.

Sapounaki-Dracaki, L., 1998. Heights and nutritional status in Greece. In: Komlos, J., Baten, J. (Eds.), The Biological Standard of Living in Comparative Perspective. Franz Steiner Verlag, Stuttgart, pp. 408–412.

Schmidt, I.M., Jørgensen, M.H., Michaelsen, K.F., 1995. Height of conscripts in Europe: is postneonatal mortality a predictor? Annals of Human Biology 22, 57–67.

Silventoinen, K., 2003. Determinants of variation in adult body height. Journal of Biosocial Science 35, 263–285.

Silvientonin, K., Lahelma, E., Lundberg, O., Rahkonen, O., 2001. Body height, birth cohort and social background in Finland and Sweden. European Journal of Public Health 11, 124–129.

Sobral, F., 1990. Secular changes in southern Portugal between 1930 and 1980 according to conscript data. Human Biology 62, 491–504.

Spencer, E.A., Appleby, P.N., Davey, G.K., Key, T.J., 2002. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. Public Health and Nutrition 5, 561–565.

Statistics Belgium, Evolution de la taille des hommes adultes dans quelques pays (1880–2004), http://statbel.fgov.be/figures/misc/t25_fr.htm (accessed 09/07/2009).

Statistics Belgium, 1906, 1920–21, 1927–28, 1933, 1939, 1971. Statistical Yearbook of Belgium. Institut National de Statistique, Brussels.

Statistics Denmark, 1892. Værnepligtiges højdeforhold i kongeriget Danmark arene 1879 til 1888. Statistiske Meddelelser, Series 3, tome 11.

Statistics Denmark, 1966. Befolkningsudvikling og sundedsforhold 1901–60. Statistike Undersøgelser, 19.

Statistics Denmark, 2008. Statistisk Aarbog 2008. København.

Statistics Netherlands, 1962. Statistical Yearbook of the Netherlands, Centraal Bureau voor de Statistiek, Den Haag.

Statistics Norway, 1929, 1935. Statistical Yearbook of Norway.

Statistics Norway, 2009. Statistisk sentralbyrå, Statistical Yearbook of Norway 2009. http://ssb.no/english/yearbook/200/tab/t-0300-120.html (accessed 08/07/2009).

Steckel, R.H., 1995. Stature and the standard of living. Journal of Economic Literature 33, 1903–1940.

Steckel, R.H., 2009. Heights and human welfare: recent developments and new directions. Explorations in Economic History 46, 1–23.

Szreter, S., 1988. The importance of social intervention in Britain's mortality decline c. 1850–1914: a re-interpretation of the role of public health. Social History of Medicine 1, 1–38.

Twarog, S., 1997. Heights and living standards in Germany, 1850–1939: the case of Württemberg. In: Steckel, R.H., Floud, R. (Eds.), Health and Welfare During Industrialization. University of Chicago Press, Chicago, pp. 285–330.

Van Meerten, M.A., 1990. Développement économique et stature en France, XIXème-XXème siècles. Annales Economies, Sociétés, Civilisations 45, 755–777.

Weir, D.R., 1993. Parental consumption decisions and child health during the early French fertility decline, 1790–1914. Journal of Economic History 53, 259–274.